BEHAVIOUR OF COMPOSITE SLAB USING FINITE ELEMENT ANALYSIS

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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Thesis submitted in fulfillment of the requirements
for the award of the
B.Eng (Hons.) Civil Engineering

Faculty of Civil Engineering and Earth Resources
UNIVERSITI MALAYSIA PAHANG

MAY 2019

ACKNOWLEDGEMENTS

A very great gratitude and appreciation expressed to all those who make a part to the successful cease of this project with title “Behaviour of unpropped composite slab using Finite Element Analysis” which involved either directly or indirectly. However, it would not have been possible without the kind of support and help from them. I would like to extend my sincere thanks to all of them

First and foremost, I would like to express my grateful and thanks to my supervisor Dr. Aizat bin Alias for his support, help, encouragement and useful guidance which I need most. I would like to give special thanks to him for having and believe on me to finish this project excellently. I also want to thank my entire friends who always at my side during Final Year Project for their idea and support about the project and as well as helping me completing it.

Finally, to my beloved family which supports me from the times, giving motivation, advices and finance support so that I can finish doing this project.

ABSTRAK

Kajian ini membentangkan element yang tidak linear 'Finite Element'(FE) bagi lantai komposit dengan menggunakan ujian lenturan empat titik. Tujuan kajian ini adalah untuk mengkaji tingkah laku lantai komposit yang diperkuat dengan C-channel di bolt di atas tulang rusuk dek keluli berprofil. Tujuan pengukuhan ini adalah untuk meningkatkan keupayaan lenturan papak komposit. Pengukuhan ini membolehkan lantai komposit untuk dibina menggunakan kaedah pembinaan yang tidak menggunakan sokongan daripada menggunakan sokongan ketika proses pembinaan. Kaedah pembinaan tanpa sokongan ini boleh mempercepatkan fasa pembinaan memandangkan masa yang kurang diperlukan untuk menyediakan dan memasang sokongan. Dalam kajian ini , Teknik pemodelan yang digunakan untuk membuat model-model (FE) dalam kajian ini disahkan dengan keputusan ujian eksperimen yang berbeza dimana keputusan eksperimen boleh diterima dengan baik. Menurut teknik pemodelan yang diverifikasi, enam lantai komposit yang terdiri daripada tiga lantai komposit tidak diperkuat dan tiga lantai komposit yang diperkuat dengan panjang yang berbeza telah dibangunkan. Kesemua enam lantai composite diuji menggukan analisis FE dan keputusan lantai composite dibandingkan diantara lantai komposit yang diperkuat dan lantai komposit yang diperkuat dengan C-channel. Keputusan menunjukkan lantai komposit yang diperkuatkan dapat menampung beban maksimum yang lebih tinggi berbanding lantai yang tidak diperkuat. Kesimpulannya, lantai komposit yang telah diperkukuhkan dapat menampung beban yang lebih tinggi berbanding lantai komposit yang tidak diperkuatkan.

ABSTRACT

This study present nonlinear finite element (FE) analysis of steel-concrete composite slab with profile deck subjected to four-point bending test. The aim of this study is to investigate the behavior of composite slabs strengthened with C-channels where the C-channels are bolted to the ribs of profiled steel deck. The purpose of this strengthening is to increase the flexural capacity of the composite slabs. This strengthening allows the composite slabs to constructed using unpropped construction method instead of propped construction, which is the most common method used in construction. This unpropped construction method could accelerate the construction phase as less time is needed to prepare and assemble the props. In this study, the modelling technique used to develop the FE models in present study was verified against disparate experimental test results where the result agrees reasonable well. According to the verified modelling technique, six composite slabs comprises of three unstrengthen composite slabs and three strengthened with different length were developed. All six slabs tested using FE analysis and compared the result the strengthened and unstrengthen composite slab. The result shows the strengthened composite slab have higher maximum load compare unstrengthen composite slab. The conclusion is strengthened composite slab can carry higher load capacity compare to unstrengthen composite slab.

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LIST OF SYMBOLS

W_c	the crack opening displacement at which stress can no longer be transferred.
σ_c	compressive stress in the concrete
ε_c	compressive strain in the concrete

CHAPTER 1

INTRODUCTION

1.1 Introduction

Composite slabs in buildings have been common in North America for many years and has experienced a rapid increase in Europe since the 1980s. Within last thirty years many advance designs for composite slab have been introduce and modified profile sheeting become available in Europe (Jiang et al., 2018).

Composite slabs are widely used in steel-concrete composite buildings because the slabs have economical features, suitable for long span structures especially for buildings require large free column areas and can reduce the construction time due to quick installation process. Most of these factors are true for propped long span composite slabs. In the case of unpropped composite slabs, it is difficult to achieve long spans but has the potential to reduce construction time as the time spend to prepare the props could be cut. Furthermore, long span unpropped composite slabs could cause excessive deflection and bending issues once the slab finished. To increase the resistance of the composite slab and reducing the deflection of the composite slab in unpropped situation, this study proposes a modified composite slab design where C-Channels are bolted to the profiled steel deck.

Therefore, this study is performed to investigate the behaviour of the modified composite slabs and compared the results with conventional composite slabs i.e. without C-channel. In order to investigate the behaviour of unpropped, the composite slabs will be model and analysed by using finite element software.

1.2 Problem Statement

Composite slab for long span structure can reduce construction time due to quick installation and simplification of the construction process (Siddh et al., 2017). This might be true for propped construction but for unpropped composite slab it is difficult to achieve long span but it can reduce the time installation by cut the time to prepare prop.

Unpropped composite slab with long span might cause the composite slabs to excessively bend and leads to failure during construction stage if not done properly. This risk is because during construction the profiled steel deck not strong enough to hold the load from wet concrete and construction load. Therefore, the composite slab needs to have additional reinforcement to reduce amount of bending. By providing additional reinforcement such as C-channel the bending resistance of composite slab can be improved. In this study, C-channels were proposed to be placed at the top of steel deck and act as reinforcement to help and reduce steel deck from bending. This additional section could increase the flexural capacity of composite slab section. Therefore, this study will investigate the behaviour of strengthen composite slabs with C-channels using finite element analysis.

1.3 The Objectives of this study are as follows;

i. To develop FE models of composite slabs using Abaqus
ii. To investigate the influence of C-channel as strengener in composite slab with profile steel deck

1.4 Scope of Study

The scope of study will cover the study of the behaviour of long span unpropped composite slab. By adding C-Channel at the top of steel deck the resistance for the bending moment can be improve.

Three-dimension model of composite slab will simulate by using Abaqus. The concrete grade 30, steel deck, C-channel and steel roller as main material will be used to create composite slab model.

The model will undergo four-point bending test to study the behaviour and load carrying capacity of the composite slabs. This test is used to determine amount of bending long span unpropped composite slab. Symmetry modelling will apply to the model which is 1m and 1.6m instead of 2m and 3.2m to reduce time for analyse

1.5 Significant of Study

Finite element method has been introduced long time ago to analysis structural problem. The behaviour of long span unpropped composite slab will be investigate and analyse by using Abaqus software.

Propped composite slabs are widely used in steel-concrete composite buildings because the slabs have economical features, suitable for long span structures especially for buildings require large free column areas and can reduce the construction time due to quick installation process. Unpropped composite slab commonly use for short span only because when use for long span it will cause failure due to excessive deflection and bending issues once the slab finished.

Hence, this study was conducted to reduce bending issues for the long span unpropped composite slab during the construction work. By add C-channel at the top of steel deck and act as reinforcement to improve resistance of bending and improve load carrying capacity of the composite slab. This method was carried out to improve the long span unpropped composite slab. This study is to upgrade long span unpropped composite so it can be served as a future reference and can be used for industry.

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